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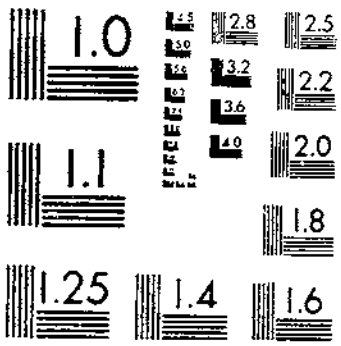

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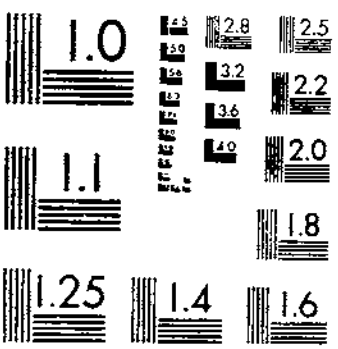

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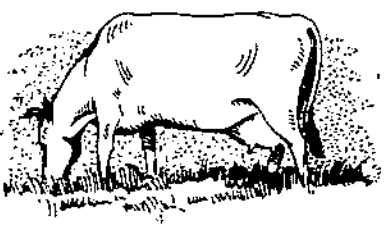
GRAZING AND GRASS-SILAGE FEEDING STUDIES at the Northern Great Plains Dairy Station

By R. F. Gaalaas and George A. Rogler



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Contents

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GRAZING AND GRASS-SILAGE FEEDING STUDIES

at the Northern Great Plains Dairy Station[1]

By R. F. Gaalaas,[2] *Dairy Husbandry Research Branch*, and George A. Rogler,[2] *Field Crops Research Branch, Agricultural Research Service*[3]

Introduction

Good quality forages are generally accepted as one of the basic requirements of a successful dairy program. Such forages, especially good quality legumes, are not as generally grown on the uplands in the northern Great Plains area as in most dairy sections. Alfalfa is grown successfully on the river bottoms and both alfalfa and sweetclover are grown to some extent on the uplands, but native grass furnishes the larger part of the forage for dairy herds in the northern Great Plains area.

Sarvis (*7*)[4] and others (*2, 3, 6*) have made extensive studies on the value of native grass and also some of the tame grasses for beef cattle, but such studies have not been made for dairy cattle.

Native grass is nutritious. However, observations over many years indicate that the period during which it furnishes good grazing for dairy cattle is short, and usually it is low in protein and probably in other milk-stimulating factors when cured as hay.

Native grass will furnish good grazing for milking cows for only 1 to 2 months of the year. Usually it is late in May or early in June before the native grass has made sufficient growth to provide adequate pasturage for heavy milking cows, and in July it usually matures enough to lose most of its milk-stimulating properties. Although beef cattle continue to make good gains on native-grass pasture until late September, dairy cattle will not continue to produce well unless they receive considerable supplemental feed. A grazing system that would extend the period of good quality grazing would be of much value to dairymen in this area.

Studies at the Northern Great Plains Dairy Station indicate that cows fed a ration of native-grass hay, corn silage, and a concentrate mixture of homegrown grains do not maintain a high level of production over a long period.[5] Although other factors may be involved,

[1] Submitted for publication December 9, 1954.

[2] Headquarters at Mandan, N. Dak.

[3] The authors wish to express their appreciation to J. R. Dawson, formerly of the Bureau of Dairy Industry, for his help in planning and carrying out the early stages of the experiment; also to C. G. Melin, Dairy Husbandry Research Branch, for making the chemical analyses of the feed samples; to Donald W. Bolin, North Dakota Agricultural College, for determining the carotene content of the silage samples; and to E. F. Miles, Northern Great Plains Field Station, for determining the moisture content of the silage samples.

[4] Italic numbers in parentheses refer to Literature Cited, p. 30.

[5] Unpublished data.

the primary reason for this failure is thought to be the low level of protein in the grass hay (6 to 8 percent). A high-protein forage that would yield well in the uplands and that could be stored and fed with native-grass hay in winter is needed to supply the proper balance of nutrients essential to sustain milk production during the winter.

In 1947, the Bureau of Dairy Industry (now Dairy Husbandry Research Branch) in cooperation with the Bureau of Plant Industry, Soils, and Agricultural Engineering (now Field Crops Research Branch) began an experiment to determine (1) whether certain adapted annual and perennial tame grasses and legumes could be used to lengthen the grazing season and to improve the quality of the pasturage; and (2) whether these forages, when stored as silage, would provide a satisfactory ration for growing dairy heifers and also help maintain a high level of production by milking cows through the winter.

Weather Data

Table 1 shows the monthly mean air temperature and seasonal average for the years 1947 through 1953; also the monthly and seasonal averages for the main period of the grazing studies (1949–53) and the silage-feeding trials (1947–51) for comparison with the longtime averages (1915–53). Table 2 shows the precipitation for the same periods.

The air temperature varied considerably from year to year, but the averages for the periods covered by these studies were close to the longtime averages, except for the low temperatures in January and March. The low March temperature may have delayed normal development of the grasses.

The amount of precipitation varied even more than the air temperature. However, the total seasonal precipitation for the periods covered by these studies was close to, but somewhat more than, the longtime seasonal total.

Grazing Studies

Experimental Plans and Procedures

Pastures for the grazing studies were laid out as follows:

Pasture 1 (5.6 acres) was fenced out of a large native-grass pasture. Pastures 2, 3, 4, and 5 were on fairly level land that had been cropped with small grains and corn in rotation for many years.

Pasture 2 (5.6 acres) was plowed and planted to sudangrass at the rate of 25 pounds per acre each spring.

Pasture 3 (5.0 acres) was plowed, disked, and harrowed in the spring of 1947, to prepare a good seedbed, and it was seeded to crested wheatgrass at the rate of 10 pounds per acre. To thicken the stand it was reseeded in the spring of 1948 with 10 pounds of crested wheatgrass per acre, by drilling the seed into the existing sod without other preparation.

Pasture 4 (5.0 acres) was plowed, disked, and harrowed in the spring of 1947, to prepare a good seedbed, and it was seeded to a mixture of 2 pounds of Ladak alfalfa, 3 pounds of crested wheatgrass, 3 pounds of Russian wildrye, 2 pounds of bromegrass, and 2 pounds of green stipagrass per acre. To thicken the stand, it was reseeded in 1948 with a mixture of 3 pounds of crested wheatgrass, 3 pounds of wildrye, and 2 pounds of green stipagrass per acre, by drilling the seed into the existing sod without other preparation.

It was found that pasture 2 (sudangrass) did not make much recovery after it was once grazed off. Therefore, pasture 5 (5.0 acres) was added in 1951. Like pasture 2, it was plowed each year and planted to sudangrass at the rate of 25 pounds per acre. However, in an effort to extend the grazing period, one pasture was seeded early (the last of May) and the other late (early in July).

All the pastures were given a light application of barnyard manure annually but no other fertilizer treatment.

All the pastures were rectangular in shape, varying from nearly square to a length-to-width ratio of approximately 3 to 1.

Good stands were obtained in pasture 3 (crested wheatgrass) and pasture 4 (grass-alfalfa) during 1947 and 1948, but grazing was deferred until 1949 to permit formation of a good sod. The pastures were clipped to control weeds in 1947 and harvested for hay in 1948. The herbage in pasture 3 was almost all crested wheatgrass, although a small percentage of sweetclover appeared in 1952 and 1953. Alfalfa made up from one-third to one-half of the total herbage in pasture 4 each year. There was a considerable percentage of weeds (mostly mustard and ragweed) in pastures 2 and 5 (sudangrass) during the earlier years, but this was reduced to a small amount by 1953.

The pastures were grazed rotationally by milking Holstein-Friesian cows. Seven cows were used in 1947, 6 in 1948, and 8 from 1949 through 1953. The same cows were kept in the group throughout each grazing season. Each year the cows were turned into the first pasture that was ready for grazing. When they had grazed down the first pasture, they were turned into the one that seemed most suited for grazing at the time. An effort was made to use enough cows in each pasture so the forage would be grazed down closely in about 2 to 3 weeks.

The cows were fed concentrates at the rate of 1 pound for each 4½ pounds of milk produced, but they received no supplemental forage while on the pastures.

Very little trouble was experienced with the cows, although there were a few minor digestive upsets and two of these were severe enough to require removal of the cow from the experiment for a short time. Only one case of bloat occurred on the grass-alfalfa pasture during the 5 years, and this responded to treatment without serious aftereffects.

Records were kept on milk and butterfat production, live weight, and concentrates fed. Records were obtained also on the production of forage in caged areas in pasture 3 (crested wheatgrass) and pasture 4 (grass-alfalfa), and consumption of dry matter was determined by the "difference" method of Knott and associates (*4*).

TABLE 1.—*Monthly mean air temperature and seasonal average, 1947–53, and monthly and seasonal averages for the periods covered by the grazing studies and the silage-feeding trials compared with the period 1915–53* [1]

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Seasonal average (Apr.–Aug.)
	° *F.*	° *F.*	° *F.*	° *F.*	° *F.*	° *F.*	° *F.*	° *F.*	° *F.*	° *F.*	° *F.*	° *F.*	° *F.*
1947	18	11	25	41	51	61	72	71	56	52	24	16	59
1948	12	8	18	44	56	63	70	71	65	46	31	12	61
1949	2	3	23	49	58	65	71	71	56	44	38	9	63
1950	−10	9	19	33	51	63	67	65	58	48	22	12	56
1951	4	12	12	40	56	59	69	64	54	42	24	5	58
1952	4	18	17	48	55	67	69	68	63	44	30	21	61
1953	16	21	26	37	52	64	69	70	59	52	36	24	58
Average:													
1947–53 [2]	7	12	20	42	54	63	70	69	59	47	29	14	60
1949–53 [3]	3	13	19	41	54	64	69	68	58	46	30	14	59
1947–51 [4]	5	9	19	41	54	62	70	68	58	46	28	11	59
1915–53	9	13	26	43	55	64	71	69	58	45	28	15	60

[1] From data recorded by the weather station at the Northern Great Plains Field Station about 2 miles north of the Northern Great Plains Dairy Station, Mandan, N. Dak.

[2] Period covered by both experiments.

[3] Period covered by grazing studies.

[4] Period covered by silage-feeding trials.

TABLE 2.—*Monthly and seasonal precipitation 1947–53, and monthly and seasonal totals for the periods covered by the grazing studies and the silage-feeding trials compared with the period 1915–53* [1]

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Seasonal total (Apr.–Aug.)
	Inch	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*
1947	0. 52	0. 15	0. 32	1. 90	0. 73	7. 72	3. 21	1. 17	1. 77	2. 15	1. 08	0. 39	14. 73
1948	. 47	. 95	. 41	3. 21	. 80	2. 32	2. 28	1. 08	. 01	1. 34	. 53	. 31	9. 69
1949	. 75	. 41	. 33	2. 54	1. 93	1. 62	4. 53	1. 22	. 60	2. 04	. 14	. 18	11. 84
1950	. 75	. 40	2. 82	2. 03	3. 13	2. 67	1. 42	2. 35	1. 65	. 58	. 36	1. 14	11. 60
1951	. 87	1. 25	. 14	. 51	1. 72	3. 28	4. 12	6. 16	. 86	. 50	. 13	. 77	15. 79
1952	. 90	1. 11	. 39	Trace	. 40	4. 38	1. 84	. 66	. 18	. 09	. 17	. 13	7. 28
1953	. 47	. 34	2. 01	2. 38	3. 21	6. 58	1. 08	2. 95	. 36	1. 69	. 39	. 30	16. 20
Average:													
1947–53 [2]	. 68	. 66	. 92	1. 80	1. 70	4. 08	2. 64	2. 23	. 78	1. 20	. 40	. 46	12. 45
1949–53 [3]	. 75	. 70	1. 14	1. 49	2. 08	3. 71	2. 60	2. 67	. 73	. 98	. 24	. 50	12. 55
1947–51 [4]	. 67	. 63	. 80	2. 04	1. 66	3. 52	3. 11	2. 40	. 98	1. 32	. 45	. 56	12. 73
1915–53	. 42	. 46	. 81	1. 51	2. 03	3. 34	2. 43	1. 61	1. 30	. 91	. 57	. 43	10. 92

[1] From data recorded by the weather station at the Northern Great Plains Field Station about 2 miles north of the Northern Great Plains Dairy Station, Mandan, N. Dak.

[2] Period covered by both experiments.

[3] Period covered by grazing studies.

[4] Period covered by silage-feeding trials.

Results

Figure 1 shows the dates and order in which the pastures were grazed each year, and table 3 shows the number of standard cow-days per acre, as determined by the method of Knott and associates (4), and the number of days the cows were on each pasture.

Pasture 3 (crested wheatgrass) was always first to be ready for grazing in the spring. Pasture 1 (native grass) and pasture 4 (grass-alfalfa) were ready from 1 to 2 weeks after pasture 3. However, the cows were turned from pasture 3 into pasture 4 rather than pasture 1, because the grass-alfalfa forage was better quality than the native-grass forage at this time and it passed the peak of quality sooner than the native-grass forage. The crested-wheatgrass pasture made sufficient recovery to be grazed a second time each year, and the grass-alfalfa pasture in 3 of the 5 years.

Grazing on pasture 1 (native grass) was deferred until fall in 1947 and 1953, as the other pastures provided sufficient grazing earlier. Also, although the native grass loses most of its milk-stimulating properties at maturity, it tends to retain more of its nutritional value after maturity than the tame grasses and therefore is more suitable for late grazing in the fall. The native-grass pasture was not grazed in 1948 because the grass was rather short before pasture 2 (sudangrass)

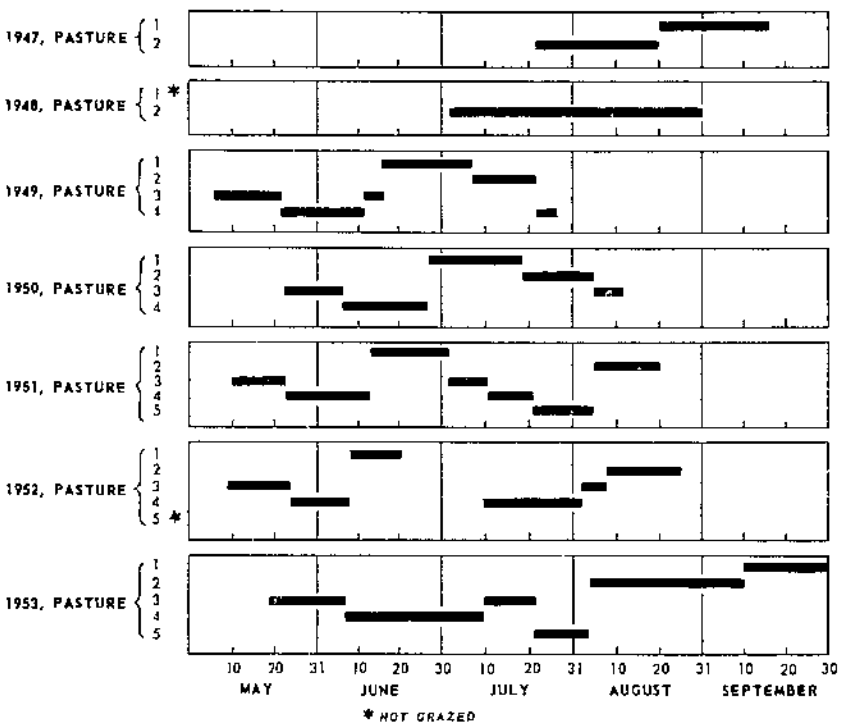

FIGURE 1.—Bars show grazing periods for pastures 1, 2, 3, 4, and 5 for the years 1947–53. Pasture 1 was native grass; pasture 2 was sudangrass; pasture 3 was crested wheatgrass; pasture 4 was grass-alfalfa mixture; and pasture 5 was sudangrass.

TABLE 3.—*Number of standard cow-days of grazing per acre on the various pastures*[1] *and number of days the pastures were grazed, 1947–53*

Year	Pasture 1 (native grass)		Pasture 2 [2] (sudangrass)		Pasture 3 (crested wheat-grass)		Pasture 4 (grass-alfalfa)		Pasture 5 [2] (sudangrass)		All pastures	
	Cow-days per acre	Days grazing	Cow-days per acre	Days grazing	Cow-days per acre	Days grazing	Cow-days per acre	Days grazing	Cow-days per acre	Days grazing	Cow-days per acre	Days grazing
	Number	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*
1947	38. 8	27	49. 5	29	-------	-------	-------	-------	-------	-------	44. 1	56
1948	0	0	83. 1	62	-------	-------	-------	-------	-------	-------	41. 5	62
1949	34. 2	21	30. 0	15	39. 4	20	40. 2	26	-------	-------	36. 0	82
1950	34. 7	22	33. 4	17	42. 0	21	42. 2	21	-------	-------	38. 1	81
1951	39. 9	18	31. 4	16	[3] 14. 1	23	50. 0	30	20. 3	16	31. 1	103
1952	17. 0	12	31. 0	23	[3] 28. 7	22	62. 9	31	0	0	27. 9	88
1953	28. 8	19	66. 6	37	42. 3	31	55. 1	33	18. 7	13	42. 3	133
Average, 1949–53	30. 9	18. 4	38. 5	21. 6	33. 3	23. 4	50. 1	28. 2	-------	-------	35. 1	97. 4

[1] As determined by the method of Knott and associates (*4*).

[2] Pasture 2 was seeded early in 1947, 1948, 1949, 1950, and 1952, and late in 1951 and 1953. Pasture 5 was seeded early in 1951 and 1953, and late in 1952.

[3] The small number of standard cow-days per acre, in spite of the normal number of days of grazing, was due to the low production of total digestible nutrients (see discussion on pages 9 and 12).

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was ready and was still too short and dry after pasture 2 had been grazed. Pasture 2 furnished an exceptionally long grazing period that year.

There was a period in late June and early July 1952 when none of the pastures were grazed because of the dry weather. Pasture 5 (sudangrass) was ready at that time but was not grazed because of the possibility of poisoning. It is well known that sudangrass pasture may contain enough prussic acid during periods of drought to poison grazing animals.

Pasture 4 (grass-alfalfa) provided the largest number of standard cow-days per acre and pasture 2 (sudangrass) the next (table 3). Pasture 4 also provided the longest grazing period during the summer, followed by pasture 3 (crested wheatgrass). The quality of the forage was very good on these pastures all 5 years.

Pastures 2 and 5 (sudangrass) varied from year to year in the amount of grazing provided. When the precipitation was favorable, both as to amount and time, growth of sudangrass was excellent but otherwise it was only fair. The quality of the forage was good, however, even when growth was short. In 1949, pasture 2 made considerable second growth after it was grazed off in July, but the weather was dry and it was not grazed a second time because of the possibility of poisoning. In 1952, pasture 5 had a good stand and a fair growth, but it had been stunted by dry weather and was not grazed because of the possibility of poisoning. Low-prussic-acid Piper sudangrass seed became available in 1953 and was used for seeding these two pastures.

Table 4 gives the yields of dry matter per acre from pasture 3 (crested wheatgrass) and pasture 4 (grass-alfalfa) as determined by clipping the herbage in caged and uncaged areas. Similar data were not obtained from the other pastures.

TABLE 4.—*Forage produced and consumed per acre (dry-matter basis), as determined by clipping data from pasture 3 (crested wheatgrass) and pasture 4 (grass-alfalfa), 1950–53*

Pasture, and clipping data		1950	1951	1952	1953	Average, 1950–53
Pasture 3 (crested wheatgrass):						
Forage produced—						
Single cut [1]	pounds	2,701	1,268	986	3,967	2,231
Clippings [2]	do	1,789	2,824	1,592	2,459	2,166
Forage consumed [3]	do	1,120	2,210	1,184	1,696	1,553
Forage consumed [4]	percent	63	78	74	69	72
Pasture 4 (grass-alfalfa):						
Forage produced—						
Single cut [1]	pounds	3,728	2,164	1,521	5,170	3,146
Clippings [2]	do	1,575	2,735	1,704	3,574	2,397
Forage consumed [3]	do	1,051	1,918	1,082	1,458	1,377
Forage consumed [4]	percent	67	70	63	41	57

[1] Yield based on data obtained from caged area cut only once at the end of the growing season.

[2] Yield based on data obtained from caged area cut at the end of each grazing period.

[3] Difference between the yields inside and outside the caged areas cut at the end of each grazing period.

[4] Obtained by dividing forage consumed by clippings.

As indicated by these data, the cows consumed larger amounts of dry matter and a higher percentage of the available herbage on pasture 3 (crested wheatgrass) than on pasture 4 (grass-alfalfa). The difference was greatest in 1953, the most favorable of the 5 years for the growth of grass and alfalfa. The grass-alfalfa pasture made an exceptionally heavy growth in 1953 and the cows did not keep it down. They had grazed only 41 percent of the available forage by the time it became so mature that they would not eat it satisfactorily and had to be removed from the pasture. If more cows had been available to put on the pasture or if part of the crop could have been harvested for hay, the return from the pasture would have been considerably greater.

The vegetative composition of pasture 4 (grass-alfalfa) in 1953 appeared to be an excellent combination of species for this area, with approximately 35 percent of alfalfa, 25 percent of crested wheatgrass, 25 percent of bromegrass, and 15 percent of Russian wildrye. Practically none of the green stipagrass was left at this time.

Table 5 gives the milk and butterfat production per acre by the cows while grazing the various pastures. Production was highest on pasture 4 (grass-alfalfa), next highest on pasture 3 (crested wheatgrass), and higher on pasture 2 (sudangrass) than on pasture 1 (native grass). As measured by current market prices for butterfat and grain, returns per acre were considerably more for the butterfat produced on these pastures, especially the grass-alfalfa and crested-wheatgrass pastures, than for small grains produced on similar land during the same years.

Table 6 shows the average gain or loss in body weight per cow per day for the various pastures, and the total gain or loss per acre. The cows not only produced well on pasture 2 (sudangrass), as shown in table 5, but they also made the largest gain in body weight per cow and per acre on this pasture. They made good gains on pasture 1 (native grass) and satisfactory gains on pasture 4 (grass-alfalfa) but showed an average loss in weight for 3 of the 5 years on pasture 3 (crested wheatgrass). Even in 1949 and 1950, when they showed an average gain on crested wheatgrass, some cows lost weight during the first period of grazing. In all 5 years most of the cows showed some gain in weight during the second period on crested wheatgrass, and in 3 of the 5 years all the cows gained weight during the second period.

These results with crested-wheatgrass pasture are contrary to results with steers on adjacent pastures [6] and cannot be explained on the basis of the forage eaten. The clipping data (table 4) indicate that the cows consumed more dry matter on the crested-wheatgrass pasture than on the grass-alfalfa pasture.

The authors have no explanation for this loss in body weight on crested-wheatgrass pature but suggest that it may be due to a loss of body "fill" rather than a loss in body substance. Each year the cows were turned into this pasture from the barn, where they had been on a ration of hay, silage, and concentrates. The crested wheatgrass was young and succulent and had a laxative effect, and it is possible that this could have resulted in a marked reduction in the amount of fill for a short time. The grazing periods were rather short, and if

[6] Rogler, G. A. Unpublished data, 1947–53.

TABLE 5.—*Total milk and butterfat produced per acre by the cows while grazing the various pastures, 1947–53*

Year	Pasture 1 (native grass)			Pasture 2 (sudangrass)			Pasture 3 (crested wheatgrass)			Pasture 4 (grass-alfalfa)			Pasture 5 (sudangrass)		
	Milk	Butterfat		Milk	Butterfat		Milk	Butterfat		Milk	Butterfat		Milk	Butterfat	
	Lb.	*Pct.*	*Lb.*	*Lb.*	*Pct.*	*Lb.*	*Lb.*	*Pct.*	*Lb.*	*Lb.*	*Pct.*	*Lb.*	*Lb.*	*Pct.*	*Lb.*
1947	988	3. 8	37. 3	1, 253	3. 7	46. 0	------	------	------	------	------	------	------	------	------
1948	------	------	------	2, 949	3. 8	111. 5	------	------	------	------	------	------	------	------	------
1949	1, 137	3. 2	36. 9	864	3. 1	27. 0	1, 453	3. 6	52. 9	1, 828	3. 4	62. 7	------	------	------
1950	1, 147	3. 2	36. 8	899	3. 2	28. 8	1, 369	3. 2	44. 3	1, 457	3. 1	44. 9	------	------	------
1951	889	3. 4	30. 0	689	3. 4	23. 6	1, 321	3. 2	42. 0	1, 799	3. 3	59. 2	748	3. 4	25. 2
1952	685	3. 2	21. 8	1, 098	3. 4	36. 7	1, 475	3. 2	47. 3	2, 041	3. 3	68. 0	------	------	------
1953	541	3. 9	20. 8	1, 567	3. 6	56. 4	1, 919	3. 7	70. 2	1, 944	3. 6	69. 5	699	3. 6	25. 2
Average, 1949–53	880	3. 3	29. 3	1, 023	3. 4	34. 5	1, 507	3. 4	51. 3	1, 814	3. 4	60. 9	------	------	------

TABLE 6.—*Gain or loss in body weight per cow per day while grazing the various pastures, and total gain or loss per acre, 1947–53*

Year	Pasture 1 (native grass)		Pasture 2 (sudangrass)		Pasture 3 (crested wheatgrass)		Pasture 4 (grass-alfalfa)		Pasture 5 (sudangrass)	
	Gain (+) or loss (−) per cow per day	Gain (+) or loss (−) per acre	Gain (+) or loss (−) per cow per day	Gain (+) or loss (−) per acre	Gain (+) or loss (−) per cow per day	Gain (+) or loss (−) per acre	Gain (+) or loss (−) per cow per day	Gain (+) or loss (−) per acre	Gain (+) or loss (−) per cow per day	Gain (+) or loss (−) per acre
	Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*
1947	+1.05	+35.5	+1.86	+67.3						
1948			+.81	+53.6						
1949	+.76	+22.7	+1.99	+42.7	+0.46	+14.8	−0.70	−29.2		
1950	+.51	+15.9	+1.78	+43.2	+.96	+32.4	+1.08	+36.2		
1951	+3.01	+77.5	+2.34	+53.6	−3.01	−106.6	+.52	+25.0	−0.44	−11.2
1952	+.54	+9.3	+.49	+16.1	−.69	−24.4	+1.69	+83.6		
1953	+1.44	+39.1	+1.88	+99.6	−.62	−31.0	+.77	+40.8	+.03	+.6
Average, 1949–53	+1.25	+32.9	+1.70	+51.0	−.58	−23.0	+.67	+31.3		

there was a reduction in the amount of fill when the cows were first put on the pasture, it is likely that they did not recover fully before the end of the grazing period. Data at this station [7] show losses in live weight of 9 to 112 pounds per cow within 2 days after a group of 8 cows were turned from the barn into crested-wheatgrass pasture. The live weights of these cows remained relatively constant at the lower level after the initial sharp loss.

Table 7 shows the yields of total digestible nutrients per acre on the various pastures, as estimated from milk-production and body-weight data by the method of Knott and associates (*4*). The yields estimated by this method are in general agreement with the yields as measured by milk production (table 5), except that the estimated yield of total digestible nutrients for pasture 3 (crested wheatgrass) is lower than for pasture 2 (sudangrass). Loss in body weight by the cows on the crested-wheatgrass pasture (see table 6 and page 9) resulted in a lower estimated yield of total digestible nutrients.

TABLE 7.—*Yield of total digestible nutrients per acre on the various pastures, 1947–53, as estimated from milk-production and body-weight data* [1]

Year	Pasture 1 (native grass)	Pasture 2 (sudan-grass)	Pasture 3 (crested wheat-grass)	Pasture 4 (grass-alfalfa)	Pasture 5 (sudan-grass)	Average (all pastures)
	Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*
1947	620. 1	791. 2	-------	-------	-------	705. 6
1948	-------	1, 329. 5	-------	-------	-------	664. 7
1949	547. 8	480. 7	630. 6	643. 7	-------	575. 7
1950	554. 5	534. 7	671. 4	675. 4	-------	609. 0
1951	638. 2	501. 6	226. 1	799. 5	324. 5	498. 0
1952	271. 4	495. 8	459. 6	1, 006. 6	-------	446. 7
1953	461. 5	1, 065. 5	676. 8	881. 2	298. 7	676. 7
Average, 1949–53	494. 7	615. 7	532. 9	801. 3	-------	561. 2

[1] Determined by the method of Knott and associates (*4*).

The plan followed in this experiment provided 3 to 4 months of good quality grazing for milking cows, whereas native grass alone usually provides 1 to 2 months. The tame grasses and legumes with the native grass required 3 to 4 acres per cow for summer grazing, whereas native grass alone requires 5 to 8 acres to furnish the same amount of nutrients.

Figure 2 shows pasture 3 (crested wheatgrass) in 1950, and figure 3 shows pasture 4 (grass-alfalfa) in 1953. These illustrations show the heavy growth of forage available to the cows when they were first turned into the pastures and also the level open prairie on which the pastures were located.

It should be noted that this grazing experiment was not designed to provide a critical comparison of the yields of the different crops. Rather, it was designed primarily to test the feasibility of using the different crops in rotation, or sequence, to extend the grazing sea-

[7] Caalaas, R. F. Unpublished data, 1954.

FIGURE 2.—General view of pasture 3—crested wheatgrass, August 1950. (Photo courtesy of Northern Pacific Railway Co.)

son and to improve the quality of the forage. The crops used fitted in very well with that plan. Crested wheatgrass furnished good quality grazing earlier every year than either the grass-alfalfa mixture or the native grass. The grass-alfalfa mixture and sudangrass furnished much better quality grazing in July and August than native grass and as good grazing or better in June, when native grass is at its best.

Silage-Feeding Studies

Experimental Plans and Procedures

Two fields (10 acres each) were selected for the studies on forage to be harvested as silage. They were on land that had been used to grow small grains and corn for many years. Both fields were given a light application of barnyard manure annually but no other fertilizer treatment.

One field was plowed, disked, and harrowed in the spring of 1947, to prepare a good seedbed, and seeded to 10 pounds of Mandan wildrye and 3 pounds of common yellow sweetclover per acre. In the spring of 1948, it was reseeded to Mandan wildrye at the rate of 5 pounds per acre, to thicken the stand. In the fall of 1948 it was reseeded to Madrid sweetclover and in the spring of 1950, to common yellow sweetclover, at the rate of 3 pounds per acre, in an effort to maintain the stand of sweetclover. The seed was drilled into the existing sod without other preparation. A reasonably good stand of wildrye was obtained. An excellent stand of sweetclover was obtained in 1948, but efforts to maintain the stand after that were only partly successful. The crop was harvested when the wildrye was in late bloom. At this stage it was past its highest nutritional value per pound, but earlier harvesting would have reduced the yield per acre.

FIGURE 3.—General view (*A*) and closeup view (*B*) of pasture 1 grass-alfalfa June 11, 1953.

The second field was plowed and seeded to a mixture of 40 pounds of Marion oats and 35 pounds of Canada field peas per acre each spring. Good stands were obtained each year. The crop was harvested when the oats were in the soft dough stage and at that time the peas usually had small pods in which peas were just starting to form.

A power grain binder was used in both fields to cut and bind the crop. The bundles were hauled to the silo as soon as possible after being cut and were put through a silage cutter set for a theoretical ¼-inch cut. The silos were the pit type, 25 to 30 feet deep and either 10 or 14 feet in diameter.

No preservative was added to the forage, but in some years it was necessary to add water to bring the moisture content to a satisfactory level. This was especially true for wildrye-sweetclover, which usually was low in moisture at the time of harvesting.

The oat-pea silage contained an estimated 75 to 85 percent of oats and 25 to 15 percent of field peas.

The wildrye-sweetclover did not make sufficient growth in 1947 to permit harvesting as silage. In 1948 the silage contained 40.4 percent of wildrye and 59.6 percent of sweetclover by weight (oven-dry basis); in 1949 it was almost 100 percent wildrye; and in 1950 it was 90 percent wildrye and 10 percent sweetclover.

Four silage-feeding trials were carried out. The plan was to use the double-reversal method, with a 10-day preliminary period followed by a 40-day experimental period. However, the single-reversal method was used in trials 2 and 3 because there was not enough wildrye-sweetclover silage to permit use of the double-reversal method, and in trial 3 it was necessary to limit the experimental period to 30 days. Also, corn silage was fed in comparison with oat-pea silage in trial 1 because no wildrye-sweetclover silage was made that year.

Trial 1 began December 19, 1947, and ended May 16, 1948; trial 2 began November 16, 1948, and ended February 24, 1949; trial 3 began January 17, 1950, and ended April 6, 1950; and trial 4 began December 22, 1950, and ended May 20, 1951.

Table 8 gives pertinent information concerning the animals used. The plan was to use two groups of Holstein cows and heifers in each trial, but no heifers were used in trials 2 and 3 because of an insufficient quantity of wildrye-sweetclover silage. The groups were balanced each year as well as possible from the standpoint of age, size, and stage of lactation. The cows in trial 2 were in a later stage of lactation than was desirable, but they were the only animals available that year.

The cows were offered 40 pounds of oat-pea silage per cow per day in all 4 trials, 40 pounds of corn silage in trial 1, and 40 pounds of wildrye-sweetclover silage in trials 2 and 3. However, in trial 3 they did not eat all the wildrye-sweetclover silage offered because of its low moisture content. The moisture content of the wildrye-sweetclover silage was low the next year also, and therefore in trial 4 the cows were limited to 35 pounds a day. The heifers were offered 25 pounds a day of oat-pea and corn silage in trial 1, and 20 pounds of oat-pea silage and 17 pounds of wildrye-sweetclover silage in trial 4. The silage was fed and the amount refused was weighed back on a group basis.

The cows and heifers were offered considerably more field-cured grass hay than they would eat. This was necessary because of the low quality of much of the hay. In trials 2, 3, and 4, the cows on oat-pea silage refused an average of 18 percent of the hay offered and the cows on wildrye-sweetclover silage refused an average of 21 percent. In trial 1, the heifers on oat-pea silage refused an average of 19 percent of the hay offered and the heifers on corn silage refused an average of 11 percent. In trial 4, the heifers on both oat-pea and wildrye-sweetclover silage refused an average of 27 percent of the hay offered. The hay was fed and the refused hay was weighed back on a group basis.

The cows were fed a concentrate mixture at the rate of 1 pound for each 4½ pounds of milk produced, adjusted every 10 days on the basis of their average production for the previous 3 days. Because of the decline in production between adjustment periods, the actual rate of feeding was higher than planned and averaged 1 pound of concentrates for each 3.66 pounds of milk for the cows on oat-pea

TABLE 8.—*Data on animals used in the silage-feeding trials (at the start of the trial)*

TRIAL 1 (DECEMBER 19, 1947–MAY 16, 1948)

Group A						Group B					
Herd No.	Age		Days in milk	Days pregnant	Live weight	Herd No.	Age		Days in milk	Days pregnant	Live weight
	Yr.-Mo.		*Number*	*Number*	*Pounds*		*Yr.-Mo.*		*Number*	*Number*	*Pounds*
Cows:						Cows:					
565	7	4	35	0	1,347	578	6	9	57	0	1,563
586	5	8	56	0	1,488	582	6	3	15	0	1,430
591	5	3	96	0	1,632	595	5	2	41	0	1,437
594	5	2	14	0	1,265	598	5	0	55	0	1,480
Average	5	10	50		1,433	Average	5	9	42		1,478
Heifers:						Heifers:					
638	1	9		0	1,035	639	1	8		83	847
640	1	7		0	713	641	1	6		45	817
642	1	6		0	888	643	1	5		0	975
Average	1	7			879	Average	1	6			880

TRIAL 2 (NOVEMBER 16, 1948–FEBRUARY 24, 1949)

Cows:						Cows:					
612	4	6	126	0	1,420	588	6	6	77	0	1,733
614	4	5	187	0	1,370	623	3	10	228	47	1,632
621	4	0	228	35	1,450	628	3	4	157	25	1,158
632	3	1	102	0	1,285	631	3	2	186	33	1,158
639	2	7	160	0	1,050	641	2	5	103	0	1,205
Average	3	9	161		1,315	Average	3	10	150		1,377

TRIAL 3 (JANUARY 17, 1950–APRIL 6, 1950)

Cows:						Cows:					
565	9	5	160	12	1,468	569	9	3	37	0	1,363
612	5	8	46	0	1,463	596	7	2	67	0	1,305
614	5	7	28	0	1,400	621	5	2	168	15	1,520
620	5	2	151	85	1,437	631	4	4	173	48	1,278
641	3	7	77	0	1,328	643	3	6	49	6	1,340
Average	5	11	92		1,419	Average	5	11	99		1,361

TRIAL 4 (DECEMBER 22, 1950–MAY 20, 1951)

Cows:						Cows:					
565	10	4	65	0	1,332	621	6	1	70	0	1,590
631	5	3	108	34	1,352	630	5	5	139	0	1,608
642	4	6	59	0	1,663	641	4	6	54	0	1,422
643	4	5	67	0	1,440	646	4	2	30	0	1,383
Average	6	2	75		1,447	Average	5	1	73		1,501
Heifers:						Heifers:					
673	1	1		0	642	674	1	1		0	625
675	1	1		0	540	676	1	0		0	637
677	1	0		0	593	678	1	0		0	535
679	0	11		0	472	680	0	11		0	467
Average	1	0			562	Average	1	0			566

silage in trials 2, 3, and 4; and 1 pound of concentrates for each 3.51 pounds of milk for the cows on wildrye-sweetclover silage in the same trials (tables 9 and 11). The concentrates were weighed for each cow individually and were consumed without waste.

The concentrate mixture was composed largely of grains grown on the station, with a small amount of protein supplement added. The mixtures used in the various trials were as follows:

Trials 1 and 2—Ground oats, 200 pounds; ground barley, 200 pounds; ground shelled corn (rainbow flint), 100 pounds; wheat bran, 100 pounds; linseed oil meal, 100 pounds; plain salt, 7 pounds; and steamed bonemeal, 7 pounds.

Trial 3—Ground oats, 200 pounds; ground barley, 300 pounds; wheat bran, 100 pounds; linseed oil meal, 100 pounds; plain salt, 7 pounds; and steamed bonemeal, 7 pounds.

Trial 4—Ground oats, 500 pounds; ground barley, 300 pounds; ground ear corn (hybrid yellow dent), 200 pounds; wheat bran, 100 pounds; linseed oil meal, 100 pounds; salt containing trace minerals, 12 pounds; and steamed bonemeal, 12 pounds.

The heifers were not fed any concentrates.

Results

Table 9 shows the average daily production of milk and butterfat by the cows during the various silage-feeding trials. There was no apparent difference in the feeding value for milk production between corn silage and oat-pea silage when fed with grass hay and a concentrate mixture (trial 1). There was a very slight but consistent difference in favor of oat-pea silage as compared with wildrye-sweetclover silage (trials 2, 3, and 4).

Table 10 shows the average gain or loss in body weight per day by the cows and heifers during the silage-feeding trials. The cows on oat-pea silage made good gains in all four trials. The cows on corn silage (trial 1) made some gain in body weight but not as much as those on oat-pea silage. The cows on wildrye-sweetclover silage made a very slight gain in weight in trial 2, a slight loss in trial 3, and a definite loss in trial 4.

The heifers made good gains on all three silages in both trials, but they made better gains on oat-pea silage than on either corn silage (trial 1) or wildrye-sweetclover silage (trial 4).

Apparently, oat-pea silage, when fed to cows with grass hay and a concentrate mixture under the conditions of these experiments, more nearly furnished all the nutrients needed for milk production and body maintenance than either corn silage or wildrye-sweetclover silage. The difference in favor of oat-pea silage, as measured by gain in weight, was very marked, especially as compared with wildrye-sweetclover silage. When fed to heifers with grass hay, the difference in favor of oat-pea silage, as measured by gain in weight, was also very marked as compared with both corn silage and wildrye-sweetclover silage.

Tables 11 and 12 show the average daily feed consumption by the cows and heifers, respectively, in the various feeding trials. The total amount of dry matter consumed by the two groups in each of the trials was very nearly the same.

TABLE 9.—*Average daily milk and butterfat production by the cows during the various silage-feeding trials* [1]

TRIAL 1

Feeding period	Oat-pea silage				Wildrye-sweetclover silage [2]			
	Group [3]	Production			Group [3]	Production		
		Milk	Butterfat			Milk	Butterfat	
		Lb.	*Pct.*	*Lb.*		*Lb.*	*Pct.*	*Lb.*
Period 1	A	44.3	3.8	1.68	B	51.3	3.2	1.63
Period 2	B	43.2	3.6	1.56	A	38.7	3.9	1.53
Period 3	A	31.9	3.4	1.09	B	35.1	3.3	1.16
Average		40.6	3.6	1.47		40.9	3.6	1.46

TRIAL 2

Period 1	A	27.0	3.3	.89	B	29.5	3.4	1.01
Period 2	B	27.1	3.5	.94	A	22.4	3.3	.74
Average		27.1	3.4	.92		25.9	3.4	.87

TRIAL 3

Period 1	A	40.7	3.3	1.33	B	36.3	3.6	1.30
Period 2	B	32.9	3.5	1.15	A	31.9	3.5	1.13
Average		36.8	3.4	1.24		34.1	3.6	1.22

TRIAL 4

Period 1	A	42.3	3.5	1.48	B	35.7	3.5	1.24
Period 2	B	32.6	3.3	1.07	A	32.1	3.6	1.16
Period 3	A	23.7	3.5	.83	B	25.8	3.4	.87
Average		32.8	3.4	1.11		31.4	3.5	1.11
Average, trials 2, 3, and 4		32.2	3.4	1.09		30.5	3.5	1.07

[1] Data are for the experimental periods, which were 40 days in trials 1, 2, and 4, and 30 days in trial 3. A 10-day preliminary period preceded each experimental period in all trials except period 1 of trial 2, which was 11 days. Production in all trials was lower during the experimental period than during the preliminary period, and the relative decrease was approximately the same for all groups in all trials.

[2] Corn silage was fed in trial 1.

[3] See table 8.

TABLE 10.—*Average gain or loss in body weight per day by cows and heifers in the various silage-feeding trials*

Animals and feeding period	Days	Oat-pea silage		Wildrye-sweetclover silage [1]	
		Group [2]	Gain (+) or loss (−) in body weight	Group [2]	Gain (+) or loss (−) in body weight
		TRIAL 1			
Cows:	*Number*		*Pounds*		*Pounds*
Period 1	50	A	−0.48	B	+0.15
Period 2	50	B	+.65	A	+.52
Period 3	50	A	+.34	B	−1.04
Average			+.29		+.04
Heifers:					
Period 1	50	A	+1.48	B	+1.71
Period 2	50	B	+1.77	A	+.76
Period 3	50	A	+1.01	B	+1.06
Average			+1.51		+1.07
		TRIAL 2			
Cows:					
Period 1	51	A	+0.33	B	+0.04
Period 2	50	B	+.20	A	−.02
Average			+.27		+.01
		TRIAL 3			
Cows:					
Period 1	40	A	+0.54	B	+0.42
Period 2	40	B	+.27	A	−.58
Average			+.40		−.08
		TRIAL 4			
Cows:					
Period 1	50	A	+0.11	B	−0.97
Period 2	50	B	+.64	A	−.07
Period 3	50	A	+.51	B	−1.37
Average			+.48		−.62
Heifers:					
Period 1	50	A	+0.99	B	+0.80
Period 2	50	B	+1.32	A	+.85
Period 3	50	A	+.76	B	+.76
Average			+1.10		+.81
Average per cow, trials 2, 3, 4			+0.38		−0.23

[1] Corn silage was fed in trial 1. [2] See table 8.

TABLE 11.—*Average daily feed consumption by the cows in the various silage-feeding trials* [1]

TRIAL 1

	Group [2]	Grass hay		Silage		Concentrates		Total dry matter consumed
		Amount consumed	Dry matter consumed	Amount consumed	Dry matter consumed	Amount consumed	Dry matter consumed	
Oat-pea silage:		*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*
Period 1	A	20. 1	17. 9	36. 3	12. 5	11. 5	10. 2	40. 6
Period 2	B	15. 9	14. 2	40. 0	18. 5	11. 5	10. 2	42. 9
Period 3	A	15. 0	13. 4	36. 7	14. 9	8. 7	7. 7	36. 0
Average		16. 7	14. 9	38. 2	16. 1	10. 8	9. 6	40. 6
Corn silage:								
Period 1	B	22. 2	19. 8	39. 7	11. 3	14. 0	12. 5	43. 5
Period 2	A	20. 2	18. 0	40. 0	12. 2	9. 7	8. 6	38. 8
Period 3	B	18. 3	16. 3	40. 0	10. 9	9. 5	8. 5	35. 6
Average		20. 2	18. 0	39. 9	11. 6	10. 7	9. 5	39. 2

See footnotes at end of table.

TABLE 11.—*Average daily feed consumption by the cows in the various silage-feeding trials* [1]—Continued

TRIAL 2

	Group [2]	Grass hay		Silage		Concentrates		Total dry matter consumed
		Amount consumed	Dry matter consumed	Amount consumed	Dry matter consumed	Amount consumed	Dry matter consumed	
		Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*
Oat-pea silage:								
Period 1	A	15.0	13.4	39.3	13.8	8.6	7.7	34.9
Period 2	B	13.3	11.8	39.3	13.8	8.3	7.4	33.0
Average		14.2	12.6	39.3	13.8	8.4	7.5	33.9
Wildrye-sweetclover silage:								
Period 1	B	13.7	12.2	39.6	12.6	8.9	7.9	32.7
Period 2	A	17.6	15.7	39.2	13.1	7.6	6.8	35.6
Average		15.7	13.9	39.4	12.8	8.2	7.3	34.1

TRIAL 3

Oat-pea silage:								
Period 1	A	17.8	15.8	40.0	13.1	11.5	10.2	39.1
Period 2	B	18.6	16.6	40.0	11.6	8.9	7.9	36.1
Average		18.2	16.2	40.0	12.4	10.2	9.0	37.6
Wildrye-sweetclover silage:								
Period 1	B	14.6	13.0	39.9	14.7	10.6	9.4	37.1
Period 2	A	14.3	12.7	35.1	14.7	9.3	8.3	35.7
Average		14.5	12.9	37.5	14.7	9.9	8.8	36.4

TRIAL 4

Oat-pea silage:								
Period 1	A	22.4	19.9	40.0	13.5	10.1	9.0	42.4
Period 2	B	21.6	19.2	40.0	13.1	7.6	6.8	39.1
Period 3	A	20.2	18.0	40.0	12.9	6.2	5.5	36.4
Average		21.5	19.0	40.0	13.2	7.8	7.0	39.2
Wildrye-sweetclover silage:								
Period 1	B	20.2	18.0	34.3	13.5	9.6	8.5	40.0
Period 2	A	21.1	18.8	35.0	15.8	8.2	7.3	41.9
Period 3	B	18.1	16.1	35.0	17.1	6.4	5.7	38.9
Average		20.2	17.9	34.8	15.5	8.1	7.2	40.6
Average, trials 2, 3, and 4:								
Oat-pea silage		17.9	15.9	39.8	13.1	8.8	7.8	36.9
Wildrye-sweetclover silage		16.8	14.9	37.2	14.3	8.7	7.8	37.0

[1] Data are for the experimental periods, which were 40 days in trials 1, 2, and 4, and 30 days in trial 3. A 10-day preliminary period preceded each experimental period in all trials except period 1 of trial 2, which was 11 days. Data for the preliminary period were approximately the same as for the experimental period in all trials.

[2] See table 8.

TABLE 12.—*Average daily feed consumption by heifers in the various silage feeding trails* [1]

TRIAL 1

Kind of silage and feeding period	Group [2]	Grass hay		Silage		Total dry matter consumed
		Amount consumed	Dry matter consumed	Amount consumed	Dry matter consumed	
		Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*
Oat-pea silage:						
Period 1	A	15.2	13.5	25.0	8.7	22.2
Period 2	B	13.3	11.8	25.0	10.8	22.6
Period 3	A	14.4	12.8	25.0	10.1	22.9
Average		14.0	12.5	25.0	10.1	22.6
Corn silage:						
Period 1	B	15.8	14.1	25.0	7.1	21.2
Period 2	A	17.0	15.1	25.0	7.6	22.7
Period 3	B	17.5	15.6	25.0	6.8	22.4
Average		16.8	15.0	25.0	7.3	22.3

TRIAL 4

Oat-pea silage:						
Period 1	A	8.4	7.5	20.0	6.7	14.2
Period 2	B	10.3	9.2	20.0	6.6	15.8
Period 3	A	10.3	9.2	20.0	6.4	15.6
Average		9.9	8.7	20.0	6.6	15.3
Wildrye-sweetclover silage:						
Period 1	B	8.7	7.7	16.9	6.6	14.3
Period 2	A	9.4	8.4	17.0	7.7	16.1
Period 3	B	9.8	8.7	17.0	8.3	17.0
Average		9.3	8.3	17.0	7.6	15.9

[1] No heifers were fed in trials 2 and 3. Data are for the 40-day experimental periods. A 10-day preliminary period preceded the experimental period in both trials. Data for the preliminary period were essentially the same as for the experimental period for all groups.

[2] See table 8.

In trials 1 and 2 the animals cleaned up the silage offered (cows, 40 pounds; heifers, 25 pounds) with little or no waste. However, as noted previously, in trial 3 the cows would not eat all of the wildrye-sweetclover silage offered because of its low moisture content. In trial 4 the moisture content of the wildrye-sweetclover silage was low also, and therefore the cows were limited to 35 pounds a day and the heifers to 17 pounds. They cleaned this up with little waste.

In trial 1 the corn silage had a higher moisture content than the oat-pea silage and therefore furnished less dry matter. Although the animals ate less wildrye-sweetclover silage than oat-pea silage in trials 3 and 4 they obtained more dry matter from the wildrye-sweetclover silage because of its low moisture content.

The wildrye-sweetclover silage was good quality each year but apparently was not quite so palatable as either the corn or oat-pea silage, as the animals did not seem to relish it as much or clean it up as quickly or as completely.

Table 13 gives the estimated average daily consumption of nutrients by the cows and heifers in the various feeding trials, and the estimated requirements for maintenance and milk production. The amounts consumed are estimated from the chemical analyses of the feeds (table 14) and the digestion coefficients as given by Morrison (5). Morrison does not give digestion coefficients for wildrye silage, so the following figures were used: Ether extract, 50 percent; crude protein, 51 percent; nitrogen-free extract, 64 percent; and crude fiber (dry-matter basis), 59 percent. These were combined with Morrison's figures for sweetclover silage, on the basis of the percentage of sweetclover present, to estimate the digestion coefficients for the wildrye-sweetclover silage as fed. The estimated requirements for maintenance and milk production are those given by Morrison (5) for "good cows under normal conditions."

All groups on oat-pea silage in all trials, except the heifers in trial 4, consumed more digestible protein than their estimated requirements. This was possible because of the high protein content of the oat-pea silage.

The cows on wildrye-sweetclover silage in trial 2 consumed more digestible protein than their estimated requirements, but the cows in trials 3 and 4 and the heifers in trial 4 consumed less than their requirements. The wildrye-sweetclover silage fed in trial 2 contained a large proportion of sweetclover (59.6 percent) and a high percentage of crude protein (14.47 percent). In trials 3 and 4 the wildrye-sweetclover silage contained 8.94 and 8.21 percent of crude protein, respectively, and the cows did not obtain enough digestible protein from the silage to meet their requirements.

The estimated total digestible nutrients consumed were above the estimated requirements for all groups in all trials.

Table 14 gives the average composition of the experimental forages on a dry-matter basis. The oat-pea silage contained more crude protein than the corn silage and more than the wildrye-sweetclover silage except in 1948. Growth of sweetclover was especially good that year, and the silage contained a high percentage of crude protein (14.47 percent). The grass hay fed in trial 2 (1948 crop) contained an exceptionally high percentage of crude protein (17.68 percent). It had been cut somewhat earlier than usual and put up under better than usual weather conditions, and some of it contained considerable sweetclover which made especially good growth that year even in some of the native-grass pastures.

A few of the silages were analyzed for carotene content, but because of unavoidable circumstances it was not possible to analyze all the silages. The values obtained for oat-pea silage ranged from 2.8 to 15.7 micrograms of carotene per 100 grams of silage (oven-dry basis) as put into the silo and from 4.1 to 8.0 micrograms per 100 grams as fed. The values for wildrye-sweetclover silage ranged from 4.1 to 7.3 micrograms per 100 grams of silage as put into the silo and from 3.7 to 4.3 micrograms per 100 grams as fed. An analysis was made of one sample of corn silage as fed, and it contained 4.9 micrograms of carotene per 100 grams of silage.

TABLE 13.—*Estimated average daily nutrient consumption by the cows and heifers in the various silage-feeding trials, compared with the estimated requirements for maintenance and milk production* [1]

COWS

Feeding trial, and experimental ration	Estimated average daily nutrient consumption in—								Estimated requirements	
	Hay		Silage		Concentrates		All feeds			
	Digestible protein	Total digestible nutrients	Digestible protein	Total digestible nutrients	Digestible protein	Total digestible nutrients	Digestible protein	Total digestible nutrients	Digestible protein	Total digestible nutrients
	Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*
Trial 1:										
Oat-pea silage	0. 61	7. 99	1. 36	10. 46	1. 41	7. 61	3. 38	26. 06	2. 80	23. 35
Corn silage	. 74	9. 66	. 63	8. 12	1. 40	7. 56	2. 77	25. 34	2. 81	23. 47
Trial 2:										
Oat-pea silage	1. 02	6. 59	1. 15	8. 94	1. 11	5. 94	3. 28	21. 47	2. 06	18. 11
Wildrye-sweetclover silage	1. 13	7. 28	1. 24	7. 40	1. 08	5. 83	3. 45	20. 51	1. 92	17. 76
Trial 3:										
Oat-pea silage	. 51	8. 75	1. 23	7. 79	1. 28	7. 44	3. 02	23. 98	2. 57	21. 71
Wildrye-sweetclover silage	. 40	6. 93	. 67	8. 49	1. 26	7. 27	2. 33	22. 69	2. 48	21. 17
Trial 4:										
Oat-pea silage	. 56	10. 41	1. 27	8. 58	. 91	5. 44	2. 74	24. 43	2. 40	20. 71
Wildrye-sweetclover silage	. 52	9. 79	. 69	8. 81	. 93	5. 59	2. 14	24. 19	2. 37	20. 54
Average: [2]										
Oat-pea silage	. 70	8. 58	1. 22	8. 44	1. 10	6. 27	3. 01	23. 29	2. 34	20. 18
Wildrye-sweetclover silage	. 68	8. 00	. 87	8. 23	1. 09	6. 23	2. 64	22. 46	2. 26	19. 82

Trial 1:										
Oat-pea silage	.51	6.69	.85	6.56			1.36	13.25	1.23	11.32
Corn silage	.61	8.04	.39	5.07			1.00	13.11	1.23	11.28
Trial 4:										
Oat-pea silage	.27	4.83	.63	4.28			.90	9.11	1.03	8.62
Wildrye-sweetclover silage	.25	4.57	.34	4.29			.59	8.86	1.03	8.62

[1] Based on the chemical analyses of the feeds and Morrison's estimates for digestion coefficients (5).
[2] Trials 2, 3, and 4.

TABLE 14.—*Average composition of the experimental forages (dry-matter basis)*

Kind of feed, year grown, and time of sampling	Samples analyzed	Average composition (dry-matter basis)				
		Ash	Ether extract	Crude protein	Nitrogen-free extract	Crude fiber
Corn silage:	*Number*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
1947—						
As fed (trial 1)	2	6.75	2.34	8.90	56.33	25.67
Oat-pea silage:						
1947—						
As put into silo	3	7.87	3.17	10.60	50.26	28.10
As fed (trial 1)	3	8.02	3.94	11.25	48.90	27.89
1948—						
As fed (trial 2)	2	7.61	3.70	11.11	48.26	29.30
1949—						
As fed (trial 3)	2	9.83	3.25	13.22	46.36	27.32
1950—						
As put into silo	7	7.31	3.31	11.75	51.53	26.12
As fed (trial 4)	3	8.09	4.13	12.93	47.38	27.48
Average, 1947–50: As fed		8.39	3.76	12.13	47.73	28.00
Wildrye-sweetclover silage:						
1948—						
As fed (trial 2)	2	6.67	2.35	14.47	41.26	35.24
1949—						
As fed (trial 3)	2	7.69	3.46	8.94	43.96	35.94
1950—						
As put into silo	5	8.06	2.31	7.04	47.75	34.84
As fed (trial 4)	3	9.43	3.05	8.21	44.02	35.29
Average, 1948–50: As fed		7.93	2.95	10.54	43.08	35.49
Grass hay:						
1947—						
As fed (trial 1)[1]	3	8.95	2.11	8.77	46.93	33.24
1948—						
As fed (trial 2)	2	9.50	2.64	17.68	36.91	33.26
1949—						
As fed (trial 3)	2	8.98	2.67	6.78	48.14	33.42
1950—						
As fed (trial 4)[2]	3	8.09	2.59	6.40	49.11	33.82
As fed (trial 4)[3]	2	7.68	3.61	6.68	49.01	33.00
Concentrates:						
As fed (trial 1)[4]	2	6.07	2.25	18.11	65.08	8.49
As fed (trial 2)	2	6.65	3.23	18.08	62.20	9.82
As fed (trial 3)[5]		6.20	4.30	17.30	64.50	8.70
As fed (trial 4)[6]	2	6.40	2.81	16.13	63.60	11.05

[1] One composite sample was analyzed for each feeding period for the cows and heifers combined.

[2] One composite sample of hay as fed to the cows in each feeding period was analyzed.

[3] One composite sample of hay as fed to the heifers in the second and third feeding periods was analyzed. The sample for the first period was lost.

[4] Average for samples fed in the first and third feeding periods; sample for second period was lost.

[5] Samples for this trial were lost. Figures shown were calculated from the analyses as given by Morrison (5).

[6] Sample for the second period showed evidence of contamination and had an abnormally high ash content and low NFE and fiber content and was omitted from the analysis.

Table 15 shows the yield per acre, on a green-matter and a dry-matter basis, of the experimental silages as compared with corn silage. The average yield per acre (dry-matter basis) was the same for oat-pea and corn silage for the 7-year experimental period. However, oats and peas as a crop have several advantages as compared with corn, such as: (1) Leaves a stubble cover on the field to protect against soil erosion; (2) permits early harvesting; (3) eliminates cultivating; and (4) controls weeds (especially wild oats) as well as corn or better.

TABLE 15.—*Green-matter and dry-matter yields per acre of oat-pea silage and wildrye-sweetclover silage compared with corn silage, 1947–53*

Year	Oat-pea silage		Wildrye-sweetclover silage [1]		Corn silage [2]	
	Green matter	Dry matter	Green matter	Dry matter	Green matter	Dry matter
	Tons	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*
1947	4.54	1.96			3.99	1.20
1948	4.05	1.30	3.53	1.31	3.55	1.07
1949	2.84	.99	1.87	.84	4.73	1.66
1950	4.63	1.56	2.35	1.11	5.49	1.65
1951	5.56	1.67	2.36	1.18	7.24	2.32
1952	3.12	1.09	1.42	.64	2.82	1.27
1953	5.00	2.25			4.88	1.71
Average [3]	4.25	1.55	2.31	1.02	4.67	1.55

[1] No wildrye-sweetclover silage was made in 1947 and 1953.
[2] The 25-year average yield for corn silage, green-matter basis, at this station is 4.64 tons.
[3] 7-year average for oat-pea and corn silage; 5-year average for wildrye-sweetclover silage.

No wildrye-sweetclover silage was made in 1947. The yield was good in 1948 but dropped sharply in 1949 because of the failure of the sweetclover. Reseeding with sweetclover in the spring of 1950 improved the yield but it dropped again in 1952 and the field was plowed up in the spring of 1953. The 5-year average yield for wildrye-sweetclover silage was less than for oat-pea and corn silage on both a green-matter and dry-matter basis.

Summary

The results of grazing studies with milking Holstein-Friesian cows at the Northern Great Plains Dairy Station, in which crested wheatgrass, a grass-alfalfa mixture, sudangrass, and native grasses were used in a rotational grazing system, are reported for the years 1949 through 1953. Also reported are the results of feeding trials in which oat-pea silage, corn silage, and wildrye-sweetclover silage were fed to growing heifers and milking cows. The heifers were fed grass hay in addition to the silage, and the cows were fed grass hay and a concentrate mixture containing mostly homegrown grains.

The results are summarized as follows:

(1) Use of adapted tame perennial and annual grasses along with native grasses in a rotational grazing system lengthened the grazing season materially and also improved the quality of the forage for milk production.

(2) Milk production per acre from the rotationally grazed tame grasses was 50 to 100 percent more than would be expected from native grasses alone.

(3) The season during which good quality forage was available for grazing was 50 to 100 percent longer on the rotationally grazed tame grasses than on the native-grass pasture.

(4) Oats and Canada field peas grown together and stored as silage made an excellent winter forage for milking cows (when fed with grass hay and a simple concentrate ration) and for growing dairy heifers (when fed with grass hay).

(5) The yield per acre of oats and peas was equal to that of corn for the period covered in this experiment.

(6) A mixture of oats and Canada peas as a crop had several advantages as compared with corn, such as: (a) Left a stubble cover on the field to protect against soil erosion, (b) permitted early harvesting, (c) eliminated cultivating, and (d) controlled weeds (especially wild oats) as well as corn or better.

(7) Wildrye-sweetclover would make a satisfactory silage if the stand of sweetclover could be maintained, but in these experiments the yield of wildrye alone was too low to be satisfactory.

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